II. Claim Rejections under 35 U.S.C. §102/103

The Examiner rejected claims 1, 6, 9, and 10 under 35 U.S.C. §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Yoo. The Examiner stated that Yoo teaches a method of controlling the critical dimension width of polysilicon, the method comprising sputtering a titanium or titanium nitride hard photoresist mask directly over a polysilicon or polycide layer and overlying a semiconductor substrate; etching the hard mask layer and polysilicon layer that are not covered by the photoresist mask, wherein the titanium hard mask is wet or plasma etched. The Examiner stated that using the same steps of Yoo would inherently result in a method for minimizing critical dimension growth of the width features located on a workpiece.

Claim 1 has been amended to recite a method for etching a pattern wherein the hard mask is exposed to the etch. The semiconductor layer of Yoo is not an etch hard mask as is used in the Applicants' invention, but is used as a light mask to prevent the reflection of actinic light from its surface (Abstract; Col. 2, lines 9-12). This prevents necking on the features of the workpiece. Further, the thickness of the semiconductor layer in Yoo is between about 100 to 400 Angstroms (Col. 3, lines 31-35), which is too thin to be an effective hard mask. Yoo uses a thick layer of spin-on glass (Col. 3, lines 34-39)as a hard mask. Yoo teaches that the spin-on glass layer may be placed between the photoresist layer and the semiconductor layer, which is further evidence that the semiconductor layer is not a true hard mask as used in the Applicants' invention, but simply an anti-reflective layer to protect against necking effects upon exposure of the photoresist layer to the actinic light. In such an embodiment, the anti-reflective semiconductor layer of Yoo would not be directly exposed to the etch. The semiconductor layer would be insufficient as a hard mask in the etching process of Yoo if used without the thick spin-on glass layer. As Yoo does not teach the use of a reactive metal hard mask that is directly exposed to the etch process to minimize growth in the critical dimension, Yoo cannot anticipate claim 1. As Yoo requires a hard mask in addition to the anti-reflective semiconductor layer, there is not teaching or suggestion that a reactive metal hard mask may be used to minimize critical dimension growth. Neither is there any motivation in Yoo to use such a hard mask by itself, or any indication that the invention of Applicants' claim 1 could be achieved with any likelihood of success. As such, claim 1 is not rendered obvious in light of Yoo. Applicants therefore respectfully request that the rejection with respect to claim 1 be withdrawn.

Claims 6, 9, and 10 depend from claim 1. As claim 1 is patentable as neither being anticipated by, nor obvious in light of, the Yoo reference, these dependent claims

should similarly be patentable. Applicants therefore respectfully request that the rejection with respect to claims 1, 6, 9, and 10 be withdrawn.

III. Claim Rejections Under 35 U.S.C. §103

The Examiner rejected claims 3, 8, 11, 12, 16, 17, 19, 20, 21, 23, 24, and 32 under 35 U.S.C. §103(a) as being unpatentable over Yoo as applied to claims 1, 13, and 30 above. Applicants respectfully point out that Yoo was not applied to claims 13 or 30 in the Office Action. The Examiner stated that Yoo fails to teach exposing the hard mask to a stream of oxidizing gas in claims 3, 8, 16, 17, 20, and 32, but that it is well known in the art to etch Ti and TiN with a carbon and fluorine gas, such as CF4, which is an oxidant.

As discussed above, Yoo fails to teach the use of a reactive metal hard mask that is directly exposed to the etch process to minimize growth in the critical dimension. There is also no teaching or suggestion that a reactive metal hard mask may be used to minimize critical dimension growth. There is no motivation in Yoo to use such a hard mask by itself, or any indication that the Applicants' invention could be achieved with any likelihood of success. As such, claims 1, 13, and 30 are not rendered obvious in light of Yoo.

Claims 3, 8, 16, 17, 20, and 32 depend from claims 1, 13, and 30. As claims 1, 13, and 30 are not rendered obvious by Yoo, neither are these dependent claims rendered obvious. Applicants therefore respectfully request that the rejection with respect to claims 3, 8, 16, 17, 20, and 32 be withdrawn.

The Examiner also stated that Yoo differs in failing to specify processing parameters as recited in claims 11 and 23, but that it would have been obvious to employ any of a variety of temperature variables including those claimed by Applicants. As mentioned above, Yoo does not render claims 1 or 13 obvious, so that claims 11 and 23, which depend from claims 1 and 13 respectively, should not be rendered obvious. Applicants therefore respectfully request that the rejection with respect to claims 11 and 23 be withdrawn.

Although Examiner stated that claims 2-5, 7, 14, 15, 18, 27, 31, 33, and 35-41 were rejected, no reasons were given for the rejection. All independent claims have been amended similar to those amendments discussed above, and Applicants believe that all pending claims are in condition for allowance as not being anticipated or obvious in light of Yoo, for reasons similar to those stated above. Applicants therefore respectfully request reconsideration of these claims.

IV. Allowable Subject Matter

The Examiner stated that claims 10, 22, and 34 contain allowable subject matter, but are objected to as depending upon a rejected base claim. Claims 10, 22, and 34 have been amended to include all limitations of the rejected base claim. Applicants respectfully submit that these claims are in condition for allowance.

V. Conclusion

In light of the above, it is respectfully submitted that all of the claims now pending in the subject patent application should be allowable, and a Notice of Allowance is requested. The Examiner is respectfully requested to telephone the undersigned if he can assist in any way in expediting issuance of a patent.

The Commissioner is authorized to charge any underpayment or credit any overpayment to Deposit Account No. 06-1325 for any matter in connection with this response, including any fee for extension of time, which may be required.

Respectfully submitted,

Date: May 22, 2001

By: _____
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Appendix

1. (Twice Amended) A method for [minimizing critical dimension growth of the width of features located] etching a pattern on a workpiece including the steps of:

selecting a workpiece with a hard mask deposited over a layer to be etched, which hard mask is comprised of a reactive metal, the hard mask further defining a first pattern comprising at least one portion having a critical dimension; and

processing the workpiece in a reactor using an etch step and exposing [using] the hard mask to the etch;[to minimize critical dimension growth of features on the layer]

whereby a second pattern is etched in the layer corresponding to the first pattern of the hard mask, and the growth of a portion of the second layer pattern is minimized in the critical dimension.

10. (Once Amended) [The method of claim 1 including the step of:]

A method for etching a pattern on a workpiece including the steps of:

selecting a workpiece with a hard mask deposited over a layer to be etched, which hard mask is comprised of a reactive metal;

processing the workpiece in a reactor using an etch step and exposing the hard mask to the etch; and

providing energy to the reactor in order to increase a rate of oxidation of the hard mask in order to slow down the rate of erosion of the hard mask.

13. (Twice Amended) A method for minimizing [critical dimension] growth of the width of features [located] etched from a layer on a workpiece including the steps of:

selecting a workpiece with a hard mask deposited over a layer to be etched, wherein said hard mask has a low sputter yield and a low reactivity to the etch chemistry of an etch process; and

processing the workpiece in a reactor using the said etch chemistry in order to etch the layer and [using] exposing the hard mask to the etch chemistry [to minimize critical dimension growth of the width features on the layer];

whereby features are created under the hard mask from the etch of the layer, the hard mask providing for minimal growth of the width of the features beyond the hard mask.

22. (Once Amended) [The method of claim 13 including the step of:]

A method for minimizing growth of the width of features etched from a layer on a workpiece including the steps of:

selecting a workpiece with a hard mask deposited over a layer to be etched, wherein said hard mask has a low sputter yield and a low reactivity to the etch chemistry of an etch process;

processing the workpiece in a reactor using the said etch chemistry in order to etch the layer and exposing the hard mask to the etch chemistry; and

providing energy to the reactor in order to increase a rate of oxidation of the hard mask in order to slow down the rate of erosion of the hard mask.

25. (Twice Amended) A method for minimizing [critical dimension] growth of the width of features [located on] etched from a layer on a workpiece including the steps of:

selecting a workpiece with a hard mask deposited over a layer to be etched, which hard mask is comprised of at least one of titanium, titanium compounds, aluminum, aluminum compounds, tantalum, tantalum compounds, tungsten, tungsten compounds, cobalt, cobalt compounds, molybdenum, and molybdenum compounds; and

processing the workpiece in the reactor using an etch step and [using] exposing the hard mask to the etch step [to minimize critical dimension growth of the features on the layer].

26. (Twice Amended) A method for minimizing [critical dimension] growth of the width of features [located on] etched from a layer on a workpiece including the steps of:

depositing on a substrate workpiece and over a layer to be etched a hard mask comprising at least one of a reactive metal, an oxide of a reactive metal, a nitride of a reactive metal, a fluoride of a reactive metal, a boride of a reactive metal, and a carbide of a reactive metal; and

processing the workpiece in the reactor using an etch step and [using] exposing the hard mask to the etch step [to minimize critical dimension growth of the width of features on the layer].

28. (Twice Amended) A method for minimizing [critical dimension] growth of the width of features [located] etched from a layer on a workpiece including the steps of:

depositing on a workpiece and over a layer to be etched a hard mask, wherein said hard mask has at least one of a low sputter yield and a low reactivity to the etch chemistry of an etch process; and

processing the workpiece in the reactor using the said etch chemistry in order to etch the layer and [using] exposing the hard mask to the etch chemistry [to minimize critical dimension growth of the features on the layer].

29. (Twice Amended) A method for minimizing [critical dimension] growth of the width of features [located] etched from a layer on a workpiece including the steps of:

depositing on a workpiece and over a layer to be etched, a hard mask which comprises at least one of titanium, titanium compounds, aluminum, aluminum compounds, tantalum, tantalum compounds, tungsten, tungsten compounds, cobalt, cobalt compounds, molybdenum, and molybdenum compounds; and

processing the workpiece in the reactor using an etch step and [using] exposing the hard mask to the etch step [to minimize critical dimension growth of the features on the layer].

30. (Twice Amended) A method of minimizing [critical dimension] growth of the width of features [located] etched from a layer on a workpiece including the steps of:

selecting a workpiece with a hard mask consisting of one of a reactive metal, an oxide of a reactive metal, a nitride of a reactive metal, a fluoride of a reactive metal, a boride of a reactive metal, and a carbide of a reactive metal, and a compound comprising any combination of an oxide, a fluoride, a nitride, a carbide, and a boride of a reactive metal, deposited over a layer to be etched; and

processing the workpiece in the reactor using an etch step and [using] exposing the hard mask to the etch step [to minimize critical dimension growth of the features on the layer].

34. (Once Amended) [The method of claim 30 including the step of:]

A method of minimizing growth of the width of features etched from a layer on a workpiece including the steps of:

selecting a workpiece with a hard mask consisting of one of a reactive metal, an oxide of a reactive metal, a nitride of a reactive metal, a fluoride of a reactive metal, a boride of a reactive metal, and a carbide of a reactive metal, and a compound comprising any combination of an oxide, a fluoride, a nitride, a carbide, and a boride of a reactive metal, deposited over a layer to be etched;

processing the workpiece in the reactor using an etch step and exposing the hard mask to the etch step; and

providing energy to the reactor in order to increase a rate of oxidation of the hard mask in order to slow down the rate of erosion of the hard mask.